11:30am - 12:00noon
OTA2.5

Room 206

Monolithic WDM Sources and Detectors for the Long Wavelength Fiber Band Based on an InP Grating Multiplexer/Demultiplexer

(invited)

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Wavelength Division Multiplexed (WDM) networks are currently attracting considerable attention worldwide. Applications envisaged are wide-ranging - from computer back-plane interconnects and the telephone local loop, through local- and metropolitan- area networks, to wide-area networks involving advanced wavelength routing schemes [1, 2].

In order for WDM systems to become a reality, the wavelength-specific components throughout the network must possess a high degree of wavelength precision, stability, and control. Most importantly, the cost of these components - which has traditionally been high - must be reduced to a minimum. This necessitates simplicity of manufacture and testing, and ease of packaging. Component reliability must also be excellent, suggesting that the highest level of integration compatible with acceptable manufacturing cost be employed.

We discuss in this paper a set of WDM components that potentially fulfills the above requirements. They are all monolithic devices that offer precise, stable, and predictable wavelength performance. Furthermore, they are all formed by adapting a common 'generic' fabrication process that is readily scalable to high volume manufacture. The components would also all share a common packaging technology.

The WDM components are based on an InP grating multiplexer / demultiplexer [3]. See Figure 1, top diagram. The body of the device consists of a planar double-heterostructure waveguide in which a diffraction grating and single mode input/output ridge waveguides have been etched. When operating as a wavelength demultiplexer, a multi-wavelength signal is fed into the 'input' guide, enters the planar guide portion and spreads out, and is then reflected and dispersed by the grating; its DMUXed components then leave the device through the 'output' guides. Operation as a wavelength multiplexer occurs when the input and output guides are used in the opposite manner.

Now, by integrating active gain stripe elements rather than etching output ridge guides, a multi-wavelength laser can be formed; see figure 1, bottom left. The laser provides addressable single- (or multiple-) wavelength emission from a single output waveguide — that which was formerly the input guide [4]. Alternatively, by integrating detectors with what were formerly the output waveguides, on-chip wavelength demultiplexed detection of the input signal is achieved [5, 6]; figure 1, bottom right. Back-to-back implementaion of the WDM detector and laser provides electronically-mediated wavelength convertion or wavelength translation. The basic MUX/DMUX may also be converted into a 'programmable' wavelength filter by incorporating active gain stripes for contolled amplification. Figures 2 and 3 demonstrate results of multi-wavelength emission and detection obtained from fabricated devices [4, 6].

The similarity of the different WDM components results in a uniformity of many of the spectral characteristics - absolute wavelength, wavelength spacing, tolerance, temperature dependence, etc. The processing sequences for the different devices, while not identical, also have a lot in common; a generic production process for all the devices might be envisaged. Fabrication of the components only involves standard photolithography and dry / wet chemical wet techniques, indicating that the process should be transferable to high volume manufacture.

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This paper will discuss the operation and performance of the InP MUX/DMUX based WDM components reported to date. The fabrication of each type of device will be discussed and the formation of a generic production process considered. Issues of wavelength accuracy, repeatabitity, and tolerance will also be addressed.

[1] C. Brackett, *J.Sel Areas in Comm.*, 8, 948, 1990.
[2] C. Brackett, *LEOS Topical Meeting on Optical Multi-Access Networks*, paper TuB1, August 1992.
[3] J.B.D. Soole et al., *Appl. Phys. Lett.*, 58, 1949, 1991.
[4] J.B.D.Soole et al., *Device Research Conference, paper IIIB-7*, June 1992.
[5] C.Cremer et. al., *I.E.E.E. Phot. Tech Lett.*, 4, 108, 1992.
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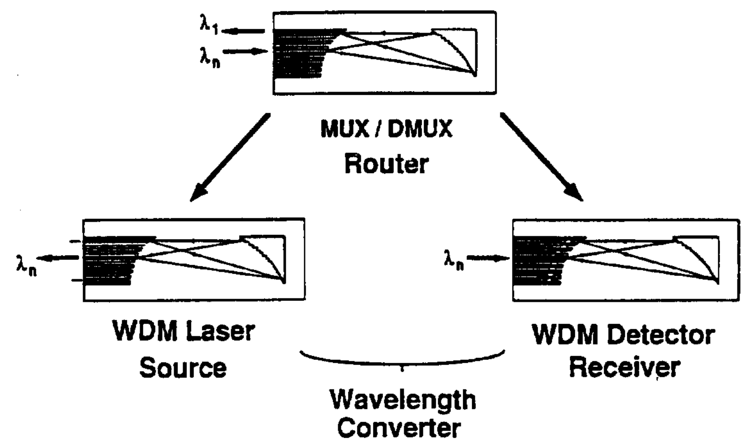

Figure1. Schematic of WDM components based on the grating MUX/DMUX.

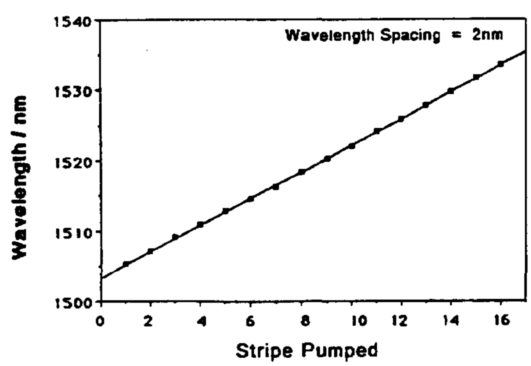

Figure 2. Laser emission at evenly spaced wavelengths from a grating-based laser. Each wavelength is generated by pumping a different active stripe.

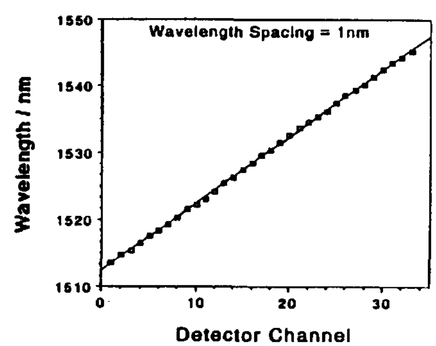

Figure 3. Wavelength demultiplexed detection. Signals on each wavelength channel are detected by a photodiode integrated on a different output waveguide.